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Introducing CASE-technology in organizations as a process of change and innovation proces

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Introducing CASE-technology in organizations as a process of change and innovation process

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Introducing new information technology, like CASE-technology, is often viewed from the perspective of the computer scientist. According to this perspective, an introduction process is nothing more than the installation of new tools, methods and techniques. In this paper the introduction process is regarded as not only a technical process, but also a process of changing people (and culture) in the organization. Thus, more aspects of the introduction process are taken into account, resulting in a better overview of the process of introducing CASE-technology.

The categorisation of Havelock is used to describe the introduction process of CASE-technology from three perspectives: the Problem Solving Perspective, the Research, Development and Diffusion Perspective, and the Social Interaction Perspective. Each of these perspectives emphasizes different aspects of a change process. Based on these aspects, a theoretical framework for CASE in organizations is developed, and partly worked out.

1. Introduction

This paper presents a conceptual framework for the introduction of CASE-environments in organizations. It is based on the assumption that a CASE-environment can be regarded as information system (a very complex information system) and introduction of CASE-environments can be regarded as a socio-technical innovation. By taking this viewpoint, it is possible to combine several theories in information systems research and organizational research, and apply these theories to the introduction of CASE environments. Thus, a framework for introduction of CASE environments is provided, not only from technical point of view, but also from organizational and political point of view.

The first section of this paper presents characteristics of the process of introducing CASE-technology. Next, the basic elements of the assumptions mentioned above are discussed: why CASE-environments can be regarded as information systems and why introduction of CASE-environments is a socio-technical innovation (Section 2). Next, theories of organizational change, and theories that describe socio-technical innovations will be discussed (section 3). These theories will be split according to the categorisation of Havelock (1971), and applied to the introduction of CASE. Finally, in section 4 a framework for the introduction process of CASE in organizations will be discussed, based on the characteristics of introduction discussed in section 2 and the discussion of the introduction process as process of change in section 3. Two aspects of the research framework will be worked out.

2. Characteristics of introduction of CASE-environments

When introducing new technology, several aspects can be taken into account. The impact of introducing CASE-environments is determined by three aspects: the characteristics of the organization in which the change is taking place, the characteristics of the introduction process itself and the characteristics of the new technology to be introduced. Or, more specific:

- the actors playing a role in the change process, the task of the organization, the structure of the organization and the technology in use (Leavitt, 1965). These are the four elements of the 'Leavitt diamond'. The Leavitt diamond is often used as a starting point for characterizing organizations and the change processes that take place in these organizations;
- the process of introducing the new technology, consisting of the technical process of introducing CASE-environments and the organizational process of introducing CASE-environments;
- the characteristics of the CASE-technology that is to be introduced.

Each of these elements will be discussed, starting with the four elements of the Leavitt diamond.

The characteristics of the Leavitt diamond

The actors that play a role in the introduction process can be categorized in three groups: the sponsor (the person or group of persons sponsoring the introduction of new technology), the change manager (the person or group of persons controlling and managing the actual introduction of the CASE-environments), and the affected workers (those people in organization whose responsibility or task structure changes due to the introduction of the new technology, including those people who will enter or leave the organization because of the introduction). Identifying the persons falling in each group can be difficult, particularly the people in the group of affected persons. Introduction of CASE-environments may cause increases in productivity of 40 to 50 %, thus affecting organizational structure and distribution of tasks. After solving the backlog problems, people may be fired, or have to be trained in other skills than they are used to cope with.

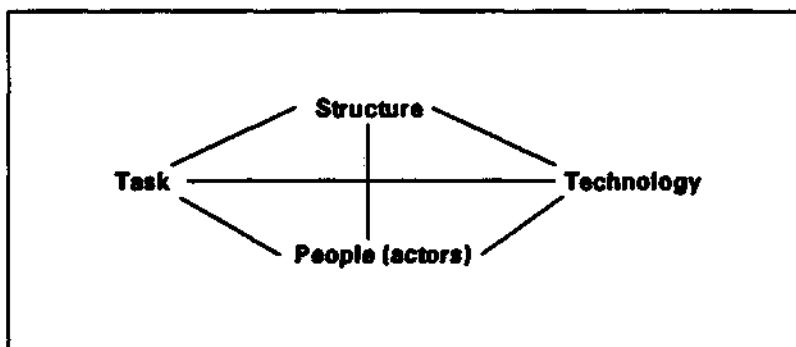


Figure 1 The Leavitt diamond (source: Leavitt, 1965)

The other three elements of the Leavitt diamond are task, structure and technology. When applied to the introduction process of CASE-technology, these three elements determine the current situation of systems development, the culture of the organization and the political structure. The last two elements are important from the perspective of acceptance of the new technology. The first element determines the level of change that has to take place to convert current systems development into systems development based on CASE-technology.

The process of introducing CASE-technology

The process of introducing CASE-technology consists of two types of aspects: the *technical* aspects, addressing the software, methods and techniques that have to be introduced, the working groups that have to be established and the way these elements are introduced, and the *organizational* (managerial) aspects that consists of all tasks to be performed to make the introduction acceptable and effective (e.g. ensuring that the resistance to change is minimal). The technical process of introducing CASE is the aspect that gets the most attention in research literature. The already classical SEI Maturity Model (Humphrey, 1989a), can be regarded as a basis for the introduction of CASE-technology from a technical point of view. According to the Maturity Model, not every organization is ready to introduce CASE-technology. A company has to pass a series of phases before it is ready to use CASE-technology. Too early introduction of CASE-technology may lead to counter-effective results (Humphrey, 1989b).

The SEI Maturity model distinguishes five levels of process maturity in organizations. Only in and after phase 3 should CASE-technology be applied. An organization should pass through each of the former phases before reaching the following phase. The Maturity Model defines the actions that should be taken to go from one phase to the next. Although the process model gives a thorough description of each phase and the tasks to be performed to reach a stage, the model suffers from a number of limitations:

- it is strongly oriented toward introduction of CASE-technology for real-time systems (since the development of the maturity model was part of research done for the Ministry of Defense). This can be concluded from the departmental characteristics of each level;
- it lacks discussion of organizational, social and political aspects of introduction of CASE-technology;
- introduction of CASE-technology depends on the characteristics of the CASE-technology itself: CASE-products can be used on limited scale in earlier phases of systems development.

The SEI is an example of a framework for introduction of CASE-technology from technical point of view. The other viewpoint of the process of introducing CASE-technology is the organizational adoption of the introduction. Not surprisingly, CASE will have dramatic effects in the organizational structure and culture. But there is not yet a framework for these aspects.

Characteristics of the CASE-technology itself

The third and last aspect of introduction of CASE-technology is the set of characteristics of the CASE-technology itself. The effects of the introduction will depend on the components of the CASE-technology that are introduced. Starting to use analysis and design tools will definitely have less effect on the organization than introduction of CASE-environment supporting all tasks of systems development and using decentralized repositories. Not considering the characteristics of the CASE-technology introduced will make a model for introducing CASE-technology less useful.

3. Introduction of CASE-technology and diffusion of an innovation

3.1. CASE-environment as a complex information system

Having discussed elements of the introduction of CASE-environments, it is time to discuss why CASE-environments may be seen as information system and result in socio-technical innovation. Information systems are usually regarded as a (complex) set of people, machines and software that interact with each other. Most definitions have in common that the elements of the system are the hardware, software and peopleware, and that the hardware and software provide additional value to data, in the form of information that can be used by the people to perform business tasks.

In order to compare a CASE-environment with the general view of an information system, we have to define what we mean by a CASE-environment. Generally speaking, CASE is software automation (McClure, 1989). A CASE environment is the environment that is capable of realising the tasks that are mentioned in the various definitions of CASE. Thus, a CASE-environment is a set of integrated CASE-products, installed on one or several computer platforms, together with the people using the CASE-products and the methods and techniques to standardize this work. This environment thus will include the following parts: the hardware on which the various CASE-products run, the software (the CASE-products themselves) with a (set of) repositories as core, and the people (users) of the environment.

The definition of CASE-environments fits perfectly well in the definition of information systems. The characteristics of the components of the CASE information system are only different in the following respects:

- the software is more sophisticated compared to the usual software in an information system. But the central part is still a database, the repository, all be it a very complex database;
- the people that interact with the CASE-information system are (not yet) the end-users, but system developers. When CASE-technology is more crystallized, the role of system developer may be taken over by the end-users, using an expert-system based CASE information system.
- the function of the information system is not a core business function, such as inventory control, management support or another operational task, but the creation and maintenance of information systems itself. A CASE-environment is an information system capable of creating and maintaining new information systems.

3.2. CASE as innovation

Introduction of CASE-environments is introduction of new technology, and can be regarded as innovation. The theory of diffusion of innovations is not widely used in research regarding information technology, but still is one of the most promising fields to start conceptualizing the impact of CASE on the organization, in terms of managerial, social and political effects. The power of CASE-environments as socio-technical innovation can be recognized when speculating about the 'ideal' CASE-environment for support of systems development. The environment has the repository as kernel. The tasks of CASE are strikingly different from the tasks that are nowadays used in systems development. The coding phase is no longer visible: coding and part of the testing is completely done by the CASE-environment. Testing is less important since the CASE-environment is capable of generating error-free code. The user generates an executable model of the system and evaluates it according to its needs. If not satisfactory enough, the user can alter parts of the development information in the repository by repeating one or all of the tasks of analysis and design. When a satisfactory executable model is generated, all the information in the repository can be used to generate the system on any hardware platform desirable. The consequences of this future view on CASE-environments are:

- introduction of this framework in an organization will lead to redesign of the responsibilities and task structures. Some tasks, as programming and several types of testing become obsolete. People with skills in these tasks should learn other skills or apply for another job;
- new tasks and responsibilities will lead to shifts in organizational culture;
- new technology will affect organizational structure, usually flattening organizational hierarchy.

Viewed from this perspective, introduction of CASE-environments is a socio-technical innovation that will have great impact on the organization. It is therefore necessary to build the basics for a framework for effect of CASE on organizations.

3.3. Change theory and diffusion theory in information system studies

According to Havelock, change and diffusion theory can be divided in three groups or 'perspectives': the Problem Solving Perspective, the Research, Development and Diffusion Perspective, and the Social Interaction Perspective (Havelock, 1971). Not all perspectives are applied in information systems research. Research on impact of information systems usually addresses the first two perspectives (Kaplan, 1991).

The Problem Solving Perspective stresses the client as essential element in the change process. The classical model underlying this perspective is the model of Lewin (1951), and consists of the phases of unfreezing, changing and refreezing of the organization. Elaborations of this model are the model of Kolb and Frohman (1970) and the model of Schein. When examining literature, these models usually address political factors of changes in organizations (see for example, Markus, 1983).

The Research, Development and Diffusion Perspective emphasizes the trajectory by which initial innovations finally reach the consumer or end-user. Central in these models is the transition of knowledge from R&D to development and diffusion. How knowledge is developed is not important. According to Kaplan, this perspective is held implicitly by many information system models. It conforms to the view of 'systems rationalism' in the research of Kling; the systems rationalism supports the ideology of scientific management, and regards users resisting the change as disfunctional.

The social-interaction models are not commonly used in information systems research (Kaplan 1990). These models analyze the diffusion aspects of change processes. The most used model underlying this perspective is the Rogers' model of diffusion of innovations (Rogers, 1983). It is commonly used in social and organizational studies and sometimes implicitly used in information systems research (Journal of Systems Management, Kling, Kling & Iacono, Kling & Scacchi). According to this model, diffusion of innovation consists of the following elements: (a) the innovation, which is communicated through (b) channels of communication, over (c) time, among (d) members of a social system. In these models knowledge is not simply communicated down the organization and is not generated according to steps as in the Research, Development and Diffusion Perspective, but flows back and forth in a complex of networks and relationships.

3.4. Introduction of CASE-environments viewed from the perspective of change

Given the three types of models discussed in the previous paragraph, it is possible to describe the introduction of CASE-environments from both three perspectives, to get a framework for the managerial, social and political implications of adaption of organizations to CASE.

Problem Solving perspective

The theories of Kling and Keen are examples of the Problem Solving perspective in information systems studies. The political issues and roles of client and change agent are the most important aspects in these models.

Introduction of CASE-technology will result in a change in responsibilities of people in the organization. Traditional systems development usually structures departments into units containing various skills in the organization. Since CASE-technology makes some skills obsolete, and creates a new role of 'analyst' having expert knowledge on some problem domain (the domain of knowledge about which information should be recorded in the information system to be developed), the structure of the organization is likely to be affected. Traditional department structure is probably to disappear, creating a single department structure for systems development or (in the case of decentralization of CASE-technology) creating additional skills in existing departments. Thus, applying the equity-implementation model (Joshi, 1991), managers of existing programming or EDP departments are likely to resist the introduction of this technology, or at least have a negative attitude toward it: responsibility of these managers may decrease. One of reasons we do not yet see this negative attitude is the backlog in systems to be developed; once this backlog problem is solved, we can expect to see a negative attitude towards introduction of new information technology.

One of the elements of a proper introduction strategy from organizational point of view should be the creation of incentives or other career opportunities for these managers. The same argument can be applied to the experts on programming (languages) and other low level computer science skills. Hard as it may be, it is possible that most of them will not be needed any more. They should be trained on other skills or may even be fired. What can be learned from this perspective is that for a proper strategy for introduction of CASE-technology, the actors playing a role in the introduction should be identified and the effect the technology will have on their responsibility and skill. The set of groups of participants mentioned earlier can be used as starting point for determining the key actors.

Research, Development and Diffusion Models

The Research, Development and Diffusion models resemble the system rationalism viewpoint. This viewpoint is very common among practitioners of CASE-technology. It represents the view that adoption of CASE-technology is necessarily good and cannot lead to decline in productivity and performance: the thought that CASE-technology is always good and should be used whenever possible. Although this viewpoint can be criticized, it can provide some useful insights, because it focuses on the tangible and measurable aspects of introduction of CASE-technology. According to this view, resistance of change will be translated into lack of rationalism. Aspects of this viewpoint to be included in the strategy for introduction of CASE are all the measurable aspects of CASE-introduction. The SEI Maturity Model clearly focuses on this perspective, since it is merely interested in the measurable elements of Software Process management.

Social Interaction Models

The Social Interaction Model leads researchers to take into account the four aspects of the classical Rogers Model of diffusion of innovation: the innovation itself, the channels of communication through which the innovation is transmitted, the timespan, and the members of the social system that are involved in the innovation. Unlike in the Problem Solving Perspective, these models do not emphasize the client itself, but the channels and relationships by which the innovation reaches the client. Group-interaction is seen as a very important factor for success of innovations. Thus, essential for creation of a correct model or strategy for describing diffusion of CASE-technology is the assessment of the mechanisms by which CASE-technology diffuses through the adopting group, the role each affected person may play in the innovation process, the impact of organization culture, and possibilities of re-invention of the system. From this perspective, research areas as groupware may be interesting.

Summarizing the perspectives

Each of the three models or perspectives on change processes can be used as a basis for a model for introduction of CASE-technology. But emphasizing only one of the models usually leads to inapplicable models, in that critical aspects of change may be overlooked. It is therefore useful to combine each of the perspectives by listing the important aspects of each perspective and putting these aspects in one model for introduction. This can be done, provided that the dimension of causal structure of each of the models are not blurred (Markus, Robey, 1988). The dimensions of causal structure are causal agency, logical structure, and level of analysis. Causal agency refers to beliefs about the nature of causality: whether external forces cause change, whether people act purposefully to accomplish intended objectives, or whether changes occur unpredictably from the interaction of people and events. Logical structure refers to the temporal aspect of theory -static vs dynamic- and to logical relationships between 'causes' and the outcomes. Level of analysis refers to the entities about which the theory poses concepts and relationships -individuals, groups, organization and society.

To avoid blurring the various levels of causal structure, it is best to view the implementation of CASE-technology from two separate perspectives: the micro-view, the perspective of the individual affected person, and the meso/macro-view, the perspective of the organization (consisting of groups that interact with each other). The levels, along with the critical aspects and the phases are given for each of the change perspectives in the following table.

	<i>Problem Solving</i>	<i>R&D, Dev. and Diffusion</i>	<i>Social Interaction</i>
<i>Level</i>	meso/macro	meso/macro	micro/meso
<i>Phases</i>	initial, unfreeze change, freeze	research, develop, diffuse	- innovation decision process - innovation development process - introduction of innovations
<i>Critical Aspects</i>	- identify actors in change process - effect on task and responsibility structure - culture - politics	- measurable aspects of Software Process	- channels of diffusion - centralize, decentralize - re-invention

Table 2 Levels, phases and critical aspects for each of the perspectives of change and diffusion

The Perspectives of Problem Solving and R&D, Development and Diffusion tend to be meso/macro level oriented. The individual affected or involved in the change process is not as important as the total process by which the change is effectuated. These two perspectives thus are more interesting for a macro view of implementation of CASE-technology. The Social Interaction Perspective on the other hand is more micro oriented. The model of Rogers, defining the acceptance or rejection of diffusion is based on the individual viewpoint. It describes the process the affected person follows in order to assess the value of a change. Therefore the Social Interaction perspective is to be used to generate a micro-level view for implementation of CASE-technology. In the following paragraphs the basics for each of the micro- and macro-level viewpoint on implementing CASE-technology will be addressed.

4. Building the basics of a framework for introduction of CASE-environments

Based on table 2 and the characteristics of introducing CASE-technology of section 2, a framework for the introduction process of CASE-environments can be defined. The essential elements of this framework are depicted in figure 3, and address five issues:

- a micro level view on implementation of CASE-technology (politics, acceptance).
- a macro level view on implementation of CASE-technology (strategy, culture).
- relation of CASE-technology to existing technology, as a basis for the micro and macro level viewpoints. E.g. how does the diffusion of CASE-technology relate to the Nolan stage model?
- the impact of cultural and political issues on the strategy for implementing CASE-technology.
- the impact of CASE-technology on the organization.

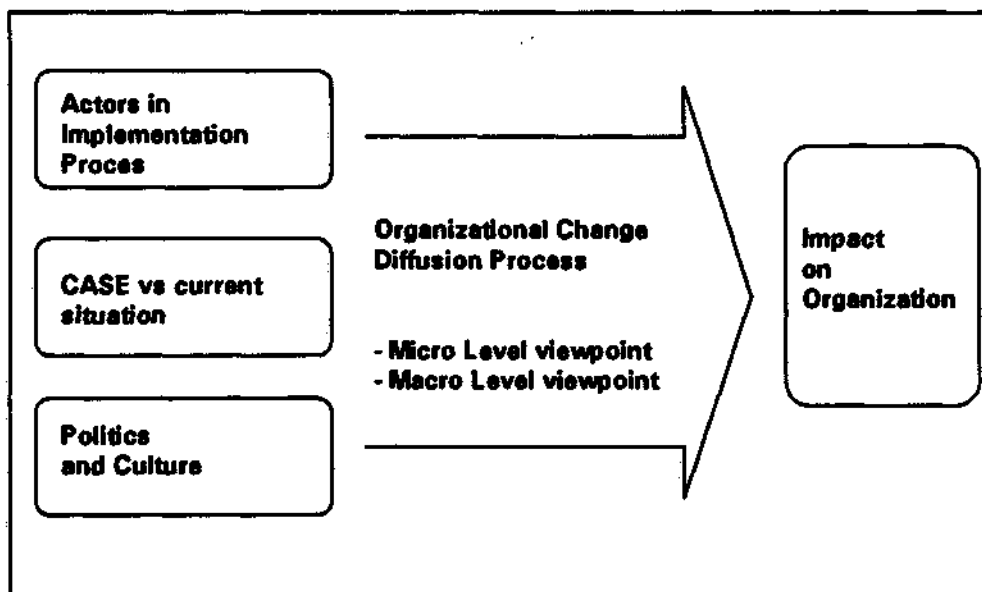


Figure 4 Issues to address in the introduction of CASE-technology

In this section, the focus is on two of the five aspects mentioned above: the micro and macro level view on implementation of CASE. These two aspects have a direct link to the organizational view on introduction processes: the theories of changes as discussed in section 3. Discussing the other aspects is out of the scope of this article.

The macro level view on implementation of CASE-technology

The framework for the macro-level view on introduction of CASE-technology in organizations has to address all aspects that are mentioned as critical from the Problem Solving Perspective and from the Research, Development and Diffusion Perspective. This means the measurable aspects as well as the organizational and cultural aspects of the change process have to be taken into account. Current research on implementation of CASE-technology, if any research is done altogether, is strongly oriented towards technical, measurable aspects of CASE-technology. In order to apply both organizational and technical aspects, it is best to split up the introduction of CASE-technology in a process that is only concerned with the technical aspects of introducing CASE-technology, and a process only concerned with the organizational, political and cultural aspects. This doesn't mean the two processes are visible as separate processes in a real life implementation of CASE-technology. It is likely that both processes are initiated, and undergone by the same persons. The intention is only to clarify the concepts by showing the differences of the aspect playing a role in the total process.

Figure 4 shows the macro-level framework that is developed, based on the Problem Solving Perspective and R&D, Development, Diffusion Perspective. The organizational and operational aspects of the introduction are separated in two diffusion processes, one that ensures the organization is 'ready' for the change from political and cultural point of view. The other process only addresses the operational tasks, the tasks conforming the traditional project management perspective.

In the framework the set of operational (project management) tasks of the introduction process is called the 'diffusion of CASE-technology'. This diffusion of CASE-technology is, apart from the assessment phase, relatively straightforward, in that the tasks do not differ to a large extent from traditional project management. However, before introducing any new technology, a review has to take place to assess if the organization is ready to use the new technology. The organization is required to have some fundamental procedures, routine and software management tasks as quality assurance and defining standards, before it is capable to use CASE-technology effectively.

The assessment of technology is only one part of the assessment to be done in the introduction process of CASE-technology. The influence of organizational characteristics, its culture and political factors on the success of the implementation of CASE also has to be assessed. Together with the assessment of the technology, this results in a picture of the organization prior to the change process, that can be used to define the appropriate actions to guarantee success of the implementation.

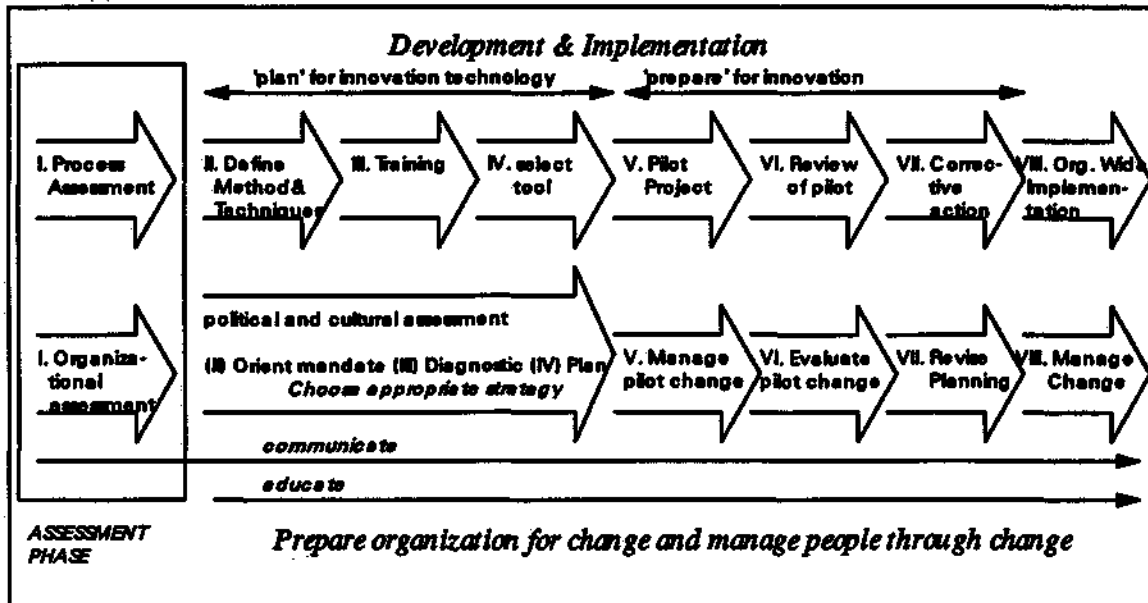


Figure 4 Macro-level view on introduction of CASE-technology

Every innovation has to be managed carefully, in order to ensure the acceptance of the change by the employees (in this case, the employees). In information technology literature, this issue is not often addressed, and in CASE-technology literature isn't mentioned at all. Nevertheless, in two of the three perspectives of change theories, management of people through change is an essential element. A possible approach to management of people is a process consisting of 6 to 7 steps: orient mandate, diagnostic, planning, management of implementation, evaluation and if possible management of a pilot project prior to the last two phases (based on Journal of Systems Management march 1991; CASE Strategies, februari 1991; IS/Analyzer, 1990). The purpose of orientation of mandate is to gain a thorough understanding of the desired change and establish the basic objectives and the mandate for those who are to install it. This can be realised conducting interviews with selected executives and affected target groups. The second step (diagnostic) builds an overview of the current situation to determine the magnitude of change that will be introduced, and the organizational readiness for change. This can be done using organizational modelling, staff surveys and personnel records. In the planning phase, the key plans for the management of people through change are developed, and the necessary measures to monitor progress are established. There are many possible tools in this phase, including modelling tools (e.g. Activity Logic, Program Logic) and project management tools. Managing Change prepares the people for the actual change process. If possible, this may first be tested in the pilot project. The change process can be managed using attitude surveys, periodic evaluations, focus groups, newsletters or a series of workshops. In the evaluation phase, the plan for change can be elaborated. Tools for the evaluation phase are final progress evaluation and operational/organizational reviews.

Micro-level view on introduction of CASE-technology

The individual confronted with the introduction of CASE-technology has to take position toward the change process: reject, or accept. This is the aspect of user-acceptance, one of the causes of sleepless nights for many system developers. There are various models describing the evaluation process of a person confronted to the introduction of new technology. Most models originate from social sciences. One of them is Rogers' model on diffusion, called the innovation decision process. This model can be elaborated to make it more useful for information systems research by combining it with other models for the process of user acceptance. One of these models is the Equity-Implementation (EI) model, translated in terms of information systems by Joshi (Joshi, 1991). In this model, the user evaluates a change on three levels:

- the individual level, to assess the consequences for the user her(him)self;
- the level of the employer, to compare the benefits of the employer to the benefits the user gets himself;
- the group level, to compare the consequences of the change to other individuals (employees) to his (her) own consequences.

Combining these models, a micro-level model for introduction of CASE-technology can be defined. The model is depicted in figure 4. Note this is only a model for the affected group, not a model for the change agent. Of course, the change agent can use this model in preparation for her actions.

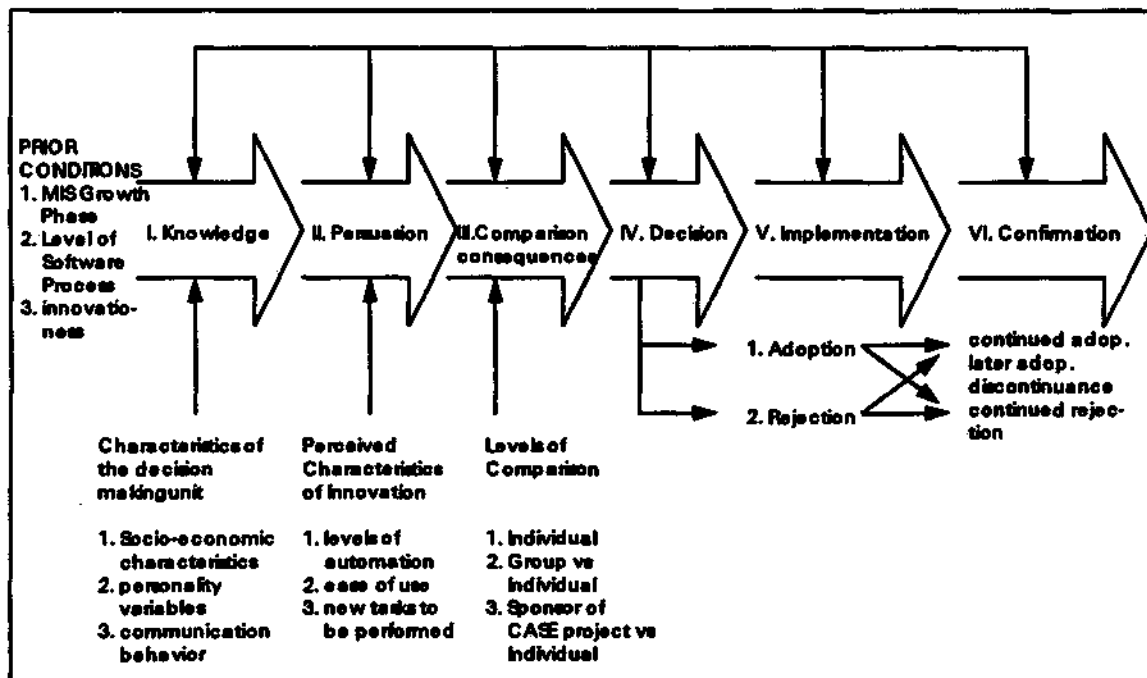


Figure 5 Micro-level framework on introduction of CASE-technology

Research areas to elaborate the framework

The models presented above are not completely defined, and research should be effectuated to elaborate the models and make them applicable to real life implementation process. But since the models are based on the three perspectives of change processes, it is unlikely the models lack critical aspects of the implementation process of CASE-technology. Research should be focused on the following aspects of the introduction of CASE:

- the actors playing a role in the introduction process;
- the critical success factors for introduction of CASE;
- define the concepts of the managerial aspects, the organizational diffusion;
- the influence of culture and politics on the success of implementation;
- the influence of other organizational factors, as merging, departmental structure (i.e. adding factors of contingency to the framework);
- influence of the level of introducing CASE, the organizational setting of CASE (centralized, decentralized etcetera).

5. Conclusions

In this paper it was discussed that introduction of CASE-technology should not only be viewed from a technical perspective. When the changes in responsibility, tasks, way of communicating between people and the change in organization culture are significant, e.g. when CASE is introduced organization-wide, it is important to pay attention to the organizational aspect of the introduction process. In these situations the technical people should be managed through change, which means a specific implementation strategy should be chosen to gain the cooperation of all people involved.

This paper discussed the concepts of the introduction process at a macro (organizational) level and at a micro (individual) level. To elaborate this framework, research should be carried out on aspects as user acceptance, contingency aspects of implementation processes (the type of strategy depends on characteristics of the organizations), and the various roles the people play that are involved in the change process. From methodological point of view, case-study research (in which the researcher has a passive role) and action research (in which the researcher has an active role) seem appropriate.

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